American Chemistry Council

THE SOLVENTS FAMILY

Welcome To
The World Of Solvents

Why so many solvents?

For many products to perform effectively, solvents are simply essential. Everyday, we benefit from the diverse range of available solvents and their unique properties.

Furthermore, the solvents industry is highly committed to the principles of product stewardship and the health and safety of downstream users.

Solvents dissolve other substances. Sugar dissolves in coffee because water is a solvent. Water is easily available and simple to handle, so why are there so many industrially important solvents?

The easy answer is that not everything dissolves in water. However, the choice of solvent is based not only on whether something dissolves or not (solvency), but also on evaporation rate, boiling point, viscosity, surface tension and many other factors that affect the thousands of industrial processes that need solvents.

With so many properties to consider and different materials to be dissolved, we can see that we need access to a wide range of solvents.

In many manufacturing processes the demands are complex because the properties required may change as the process is carried out. For example, to achieve a surface with a good gloss finish, it may be necessary initially for the solvent to evaporate quickly but at a later stage evaporate much slower. This and many other tailored performances can be achieved by blending together different solvents from the solvents family tree.

The Oxygenated and Hydrocarbon Solvents Family Tree

The chemical classification of solvents is based on their chemical structure. Hydrocarbon solvents are molecules containing only hydrogen and carbon atoms. Oxygenated solvents contain hydrogen, carbon and oxygen atoms [1].

Most solvents are manufactured from petroleum (oil). The manufacturing process is highly integrated into the operation of an oil refinery or in a petrochemical manufacturing site. Up to 10% of solvents are manufactured using other raw materials (natural gas, coal or biomass).

Most hydrocarbon solvents are separated in the refinery by distillation and then further treated and purified. Some are synthesised from olefins. Hydrocarbon solvents are classified into three sub-groups based on the type of "carbon skeleton" of their molecules, giving us the aliphatic, aromatic and paraffinic solvents families.

Oxygenated solvents are produced through chemical reactions from olefins (derived from oil or natural gas), giving us the following sub-groups: alcohols, ketones, esters, ethers, glycol ethers and glycol ether esters.

This leaflet gives only a few examples of how solvents can be used to benefit consumers; in reality, there are thousands of other applications.

1 *The group of chlorinated solvents manufactured by reacting hydrocarbons with chlorine are not discussed in this document. For information on chlorinated solvents, contact the European Chlorinated Solvents Association at www.eurochlor.org or the Halogenated Solvents Industry Alliance (HSIA) at www.hsia.org.*

1. Family: Alcohols

Ethanol is used by perfume manufacturers as their solvent of choice because of its low odour. The low boiling point of ethanol means that the solvent evaporates quickly and does not remain on the skin.

2. Family: Alcohols

Isopropyl alcohol is used as a windscreen de-icing and cleaning solvent because it stays in liquid form well below freezing point and therefore helps to remove the ice. It removes stains that appear on the windscreen and is also used in the home in window cleaning products.

3. Family: Ketones

Ketones such as acetone, MEK (Methyl ethyl ketone) and MIBK (Methyl isobutyl ketone) are used in carbon fibre composites to make skis.
The carbon fibres are layered with epoxy resins and the ketone's high solvency power softens the resin to apply it easily and evenly between the layers. The solvent's low boiling point allows it to evaporate quickly to enable the layers to bind easily and form a strong, durable product.

4. Family: Esters

Ethyl acetate is used in nail polish and is especially valued for its fruity odour and fast-drying properties. It is also used in nail polish removal fluids and its high solvency power means that the polish can be removed easily from the nail.

5. Family: Esters

Butyl acetate is used to purify penicillin by keeping impurities in solution whilst the penicillin is selectively removed from the reaction mixture by extraction. Further purification of the penicillin is achieved through the method of crystallization.

6. Family: Glycol ethers

Glycol ethers are highly effective as an active component of heavy-duty glass, floor and other hard surface cleaning formulations. These solvents have good water compatibility, high solvency for greases and oils and good biodegradability.

7. Family: Glycol ether esters

Glycol ether esters are added to spray paints to prevent them from drying before they hit their target. The slow evaporation of this powerful group of solvents means that cars, for example, can be re-painted effectively.

8. Family: Aliphatic hydrocarbons

Aliphatic hydrocarbons (typically dearomatised hydrocarbons) are used in the preservation of timber. The high water resistance and low surface tension of the solvent enables it to penetrate the wood.

9. Family: Aliphatic hydrocarbons

Commercial hexanes are used to extract natural oil from seeds due to its optimum solvency power (like dissolves like). Hexane is a light solvent that is easily removed from the edible oil and is also recycled during the process.

10. Family: Aliphatic hydrocarbons

High boiling point hydrocarbon solvents are used in the aluminium rolling process to make aluminium foil. Acting as a lubricant, the solvent protects the metal from oxidation, helps eliminate metal dusts/chips and dissipates the heat from the process.

11. Family: Aromatic hydrocarbons

Toluene is used as the ink solvent in a specialised type of magazine printing, "publication rotogravure", because it evaporates quickly enough to prevent smudging and is easily recycled. The process of rotogravure is capable of producing printed material of the highest quality.

12. Family: Paraffins

Pentanes are used to make plastic foams for insulation purposes in household goods such as refrigerators and freezers. The low boiling point of pentanes is the important property. Pentane is mixed into liquid plastic, which is then heated with steam; the pentane vapourises inside the plastic and expands to form a honeycomb-like plastic foam. The low thermal conductivity of the foam helps it to act as a highly effective insulator.

13. Family: Paraffins

Isoparaffins are used to dry-clean clothes. These solvents are valued for their low odour, favourable health and environmental profile, safe handling characteristics and excellent cleaning efficiency.

14. Family: Aliphatic hydrocarbons

Dearomatised aliphatic hydrocarbons with specific boiling point ranges are used in the production of tyres. The solvent softens and cleans each rubber layer before the next one is applied and its adhesive qualities help to bind together the various components of the tyre for increased safety and improved performance.

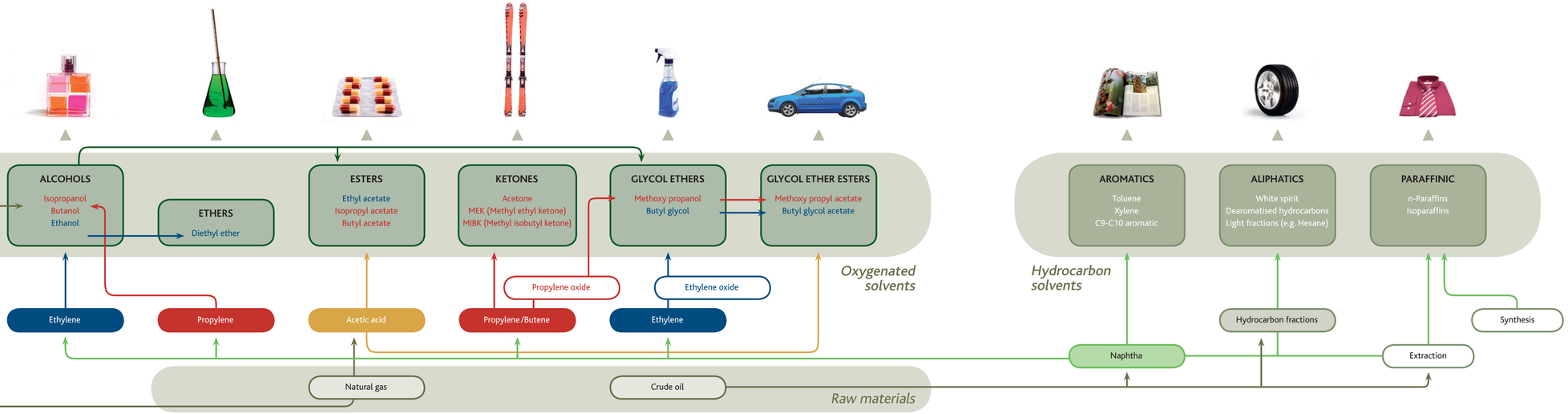
15. Family: Aliphatic hydrocarbons

Low volatility dearomatised aliphatic hydrocarbons are used in the oilfield as base fluids in drilling mud formulations for lubricating the drilling process in oil wells. The solvents have excellent lubricating properties, are inert towards most type of rock formations, and have low toxicity and high biodegradability.

16. Family: Aliphatic hydrocarbons

Aliphatic hydrocarbons are used to extract metals such as copper, nickel, cobalt and zinc from ore. They provide excellent solubility and allow a rapid reaction of the metal to remove it from the ore, then a quick separation of the solvent-metal mix.

The Solvents Family



"The Solvents Family" is a result of cooperation between the European Solvents Industry Group (ESIG) and the American Chemistry Council (ACC) through its Solvents Industry Group.

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